IS 11916 (2001): Textiles - Continuous Filament Glass Yarn for Aerospace and other Purposes [TXD 13: Textile Materials for Aerospace Purposes]

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IS 11916 : 2001
(Reaffirmed 2000)

भारतीय मानक

वस्त्रादि — वायुआकाशीय तथा अन्य कार्यों के लिए सतत तन्तु ग्लास के धागे — विशिष्टि

(पहला पुनरीक्षण)

Indian Standard

TEXTILES — CONTINUOUS FILAMENT GLASS YARN FOR AEROSPACE AND OTHER PURPOSES — SPECIFICATION

(First Revision)

ICS 49.025.60

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 6

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Textiles Materials for Aerospace Purposes Sectional Committee had been approved by the Textile Division Council.

This standard which was originally published in 1986 has been taken up for revision on the basis of experience gained during its implementation. In the revised version, following changes have been carried out :

a) Nominal linear density of the yarn generally used have been modified as 33 tex, 66 tex and 134 tex in place of 34 tex, 68 tex and 136 tex respectively;

b) Requirement for electrical conductivity has been modified;

c) Traverse speed for carrying out tensile strength test has been increased to 300 mm/min from 50 mm/min;

d) Characteristics of sizing formulations to be used also been included; and

e) Parameters for 13 micron diameter monofilament have been included.

The composition of the committee responsible for formulation of this standard is given in Annex D.

There is no corresponding International Standerd on the subject.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

TEXTILES — CONTINUOUS FILAMENT GLASS YARN FOR AEROSPACE AND OTHER PURPOSES — SPECIFICATION

(First Revision)

1 SCOPE

This standard prescribes the requirements for a series of sized but otherwise untreated glass fibre yarns of continuous filament type produced from low alkali 'E' glass composition for aerospace and other purposes.

2 REFERENCES

The following Indian Standards contian provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standard indicated below:

IS No.	*Title*
832 : 1985	Methods for determination of twist in yarn (*first revision*)
1390 : 1983	Methods for determination of *p*H value of aqueous extract of textile materials (*first revision*)
2303 : 1963	Method of grading glass for alkalinity
4420 : 1967	Methods for determination of conductivity of aqueous and organic extracts of textile materials
SP 45 : 1988	Handbook on glossary of textile terms

3 TERMINOLOGY

In addition to definitions given in SP 45 : 1988 following shall apply.

3.1 'E' Glass

A low alkali glass composition containing not more than 1.0 percent alkali metal oxides expressed as Na_2O.

4 DESIGNATION OF THE YARN

4.1 Elements of the Designation

The elements in the designation shall appear in the order of sequence given below (*see also* Table 1):

a) *Single Continuous Filament Yarn*

1) Type of glass used;
2) Letter 'C' for continuous filament yarns;
3) Nominal diameter, in micrometres, of the filaments, followed by a space (*see* Table 2);
4) Linear density, in tex, followed by a space;
5) Direction of twist, followed by a space; and
6) Amount of twist, expressed in turns per metre.

Example : EC9 33 Z 40

NOTE — When several strands are assembled in parallel and twisted together, give only the total linear den sity of all the strands before twisting. For example, starting with four strands of EC9 33 and twisting these together, the designation of the resulting yarn is EC9 132 Z 40.

b) *Doubled/Plied Continuous Filament Yarn Having Identical Components*

1) Designation of the single continuous filament yarn used without indication of the direction and the amount of twist followed by a space;
2) Multiplication sign, ×, followed by a space;
3) Number of single continuous filament yarns, being twisted, followed by a space;
4) Direction of doubling/plying twist; followed by a space; and
5) Amount of doubling/plying twist, expressed in turns per metre.

Example EC9 33 × 2 S 160

NOTE — For yarn identification, *see* Table 1.

5 REQUIREMENTS

5.1 Material

5.1.1 Alkali content of the glass used shall not be more than 1.0 percent expressed as Na_2O when determined by the method given in IS 2303.

5.1.2 Diameter of monofilament shall be as given in Table 2 when tested by the method given in Annex A.

5.2 Yarn Twist

5.2.1 Unless otherwise agreed to between the buyer and the seller, the single yarn shall have a nominal twist of 40 turns per metre in Z direction and the doubled yarn shall have a nominal twist of 160 turns per metre in S direction when tested by the method given in IS 832.

5.2.1.1 The mean twist found for each package shall not differ from the nominal twist by :

a) ± 20 percent for single yarn with a twist of 40 turns per metre or less,

b) ± 15 percent for single yarns with a twist of more than 40 but not more than 150 turns per metre, and

c) ± 15 percent for plied yarn with a twist up to 150 turns per metre.

NOTE — The requirements given in **5.2.1.1** are for guidance only.

Table 1 Guide to Yarn Identification System

(*Clause* 4.1)

Filament Code	Yarn Count (Glass System)	Yarn Designation (tex)
(1)	(2)	(3)
ECD	900 1/0	EC5 5.5 Z 40
ECD	450 1/0	EC5 11 Z 40
ECE	225 1/0	EC7 22 Z 40
ECG	150 1/0	EC9 33 Z 40
ECG	75 1/0	EC9 66 Z 40
ECG	37 1/0	EC9 134 Z 40
ECD	900 1/0	EC5 5.5 Z 160
ECD	900 1/2	EC5 5.5 Z × 2 S 160
ECD	900 1/3	EC5 5.5 Z × 3 S 160
ECD	450 1/0	EC5 11 S 160
ECD	450 1/2	EC5 11 × 2 S 160
ECD	450 1/3	EC5 11 × 3 S 160
ECD	450 2/2	EC5 11 × 2 × 2 S 160
ECD	450 2/3	EC5 11 × 2 × 3 S 160
ECD	450 2/5	EC5 11 × 2 × 5 S 160
ECD	450 3/3	EC5 11 × 3 × 3 S 160
ECD	450 3/4	EC5 11 × 3 × 4 S 160
ECD	450 5/7	EC5 11 × 5 × 7 S 160
ECE	225 1/0	EC7 22 Z 160
ECE	225 1/2	EC7 22 × 2 S 160
ECE	225 1/3	EC7 22 × 3 S 160
ECE	225 2/2	EC7 22 × 2 × 2 S 160
ECE	225 2/3	EC7 22 × 2 × 3 S 160
ECE	225 2/5	EC7 22 × 2 × 5 S 160
ECE	225 3/3	EC7 22 × 3 × 3 S 160
ECE	225 3/4	EC7 22 × 3 × 4 S 160
ECE	225 5/7	EC7 22 × 3 × 7 S 160
ECG	150 1/0	EC9 33 Z 160
ECG	150 1/2	EC9 33 × 2 S 160
ECG	150 1/3	EC9 33 × 3 S 160
ECG	150 2/2	EC9 33 × 2 × 2 S 160
ECG	150 2/3	EC9 33 × 2 × 3 S 160
ECG	150 2/4	EC9 33 × 2 × 4 S 160
ECG	150 2/5	EC9 33 × 2 × 5 S 160
ECG	150 3/3	EC9933 × 3 × 3 S 160
ECG	150 3/4	EC9 33 × 3 × 4 S 160
ECG	150 4/5	EC9 33 × 4 × 5 S 160
ECG	150 5/7	EC9 33 × 5 × 7 S 160
ECG	75 1/0	EC9 66 S 160
ECG	75 1/2	EC9 66 × 2 S 160
ECG	75 1/3	EC9 66 × 3 S 160
ECG	37 1/0	EC9 134 S 160
ECG	37 1/2	EC9 134 × 2 S 160
ECG	37 1/3	EC9 134 × 3 S 160
ECG	37 1/5	EC9 134 × 5 S 160

NOTE — The exact TPM, both for single and plied yarns are known to vary from manufacturer to manufacturer, hence; this table is for guidance only.

5.2.1.2 The mean twist of each lot shall not differ from the nominal twist by :

a) ± 15 percent for single yarns with a twist of 40 turns per metre or less,

b) ± 7 percent for single yarns with a twist of more than 40 but not more than 150 turns per metre, and

c) ± 10 percent for plied yarns with a twist up to 150 turns per metre.

5.3 Grade

5.3.1 Glass yarn shall be classified as given in Table

2 depending upon the monofilament diameter.

Table 2 Monofilament Diameter

(*Clauses* 4.1, 5.1.2 *and* 5.3.1)

Nominal Diameter for Coding (Microns)	Mean Diameter (Microns)	Tolerance	Filament Designation
(1)	(2)	(3)	(4)
5	5.71	± 0.65	D
7	6.99	± 0.65	E
9	9.74	± 0.83	G
13	13.0	± 0.83	K

5.4 Linear Density

5.4.1 The linear density of glass yarn shall be as given in Table 3 when tested by the method given in Annex B.

5.4.2 The coefficient of variation of the linear density of glass yarn shall be less than 10 percent and tex deviation from the standard value (*see* Table 3) less than 6.5 percent when calculated by the formula given in **B-7.4** and **B-7.5**.

5.5 Tensile Strength

The minimum average tensile strength of glass yarn shall be as given in Table 3 when tested by the method prescribed in Annex C.

5.6 Ignition Loss

The ignition loss of glass yarn when determined by method given in Annex B shall not be more than 3 percent. However, in case of glass yarn with nominal diameter of 5 microns, it shall not be more than 4 percent.

Table 3 Yarn Tex and Tensile Strength

(*Clauses* 5.4.2, 5.5, 7 *and* B-7.5)

Yarn Count (Glass System)	Yarn Designation	Linear Density, Tex	Mean Single Yarn Breaking Strength (kgf)
(1)	(2)	(3)	(4)
900 1/0	EC5 5.5 Z 40	5.5	0.22
450 1/0	EC5 11 Z 40	11	0.44
225 1/0	EC5 22 Z 40	22	0.90
150 1/0	EC5 33 Z 40	33	1.35
75 1/0	EC5 66 Z 40	66	2.47
37 1/0	EC5 134 Z 40	134	5.0

NOTE — This table gives only breaking strength of single yarn because breaking strength of doubled or plied yarn shall generally be multiples of that of basic single yarn.

5.7 *p*H Value of Aqueous Extract

The *p*H value of the aqueous extract of glass yarn shall be within the range 7.0 to 10.0 when determined by the method given in IS 1390.

5.8 Electrical Conductivity

The electrical conductivity of the aqueous extract of glass yarn shall not exceed 7.0 micro-simens per metre when tested by the method given in IS 4420.

5.9 The glass yarn shall be sized with starch/dextrin and the following shall be ensured:

a) Ash content of starch/dextrin shall be less than 0.5 percent;

b) *p*H of 5 percent solution of starch/dextrin at 25° C shall be 6.0 ± 1.0;

c) Formaldehyde content shall be 0.3 percent on overall size formulation and 3 percent on starch/ dextrin content; and

d) Hydrogenated vegetable oils as ingredient to sizing formulation shall have following characteristics:

Melting point 40 ± 2°C

Acid value 0.15 *Max*

Saponification value 140-200

5.10 Visual Inspection

5.10.1 The cops when visually inspected shall meet the requirements specified in **5.10.1.1** to **5.10.1.6**.

5.10.1.1 *Freedom from dark streaks and dirty joints*

Three or more such streaks each 5 cm in length on individual cop surface or in under layers may occur. If the cops can be stripped to remove such streaks, then this may be done.

5.10.1.2 *Loose yarn at tapered end of the cops (sloughing off)*

Cops shall be free from loose yarn, shiny yarn (lack of size) and sloughing off at tapered end. The occurrence of such cops will render them subject to stripping as per agreement between the buyer and the seller.

5.10.1.3 In case of plied yarn, the cops shall have perfectly balanced yarn. Unbalanced yarn shall be determined by holding the ends of one metre of yarn 2 cm apart. Obvious rapid spiralling will indicate unbalance in the yarn.

5.10.1.4 Cops shall be free from dirty and loopy yarn. Three or more such loops on individual cop surface shall necessitate stripping. Loops appearing in under layers shall be dealt similarly.

5.10.1.5 The cops shall be reasonably free from filamentation and hairiness.

5.10.1.6 The cops shall also be reasonably free from the following defects :

a) Flared package;
b) Undercut package;
c) Damaged tubes or bobbins (with cuts, bruises or breaks);
d) Cracked winding (partial gap in winding);
e) Entrapped waste;
f) Entrapped foreign matter;
g) Protruding end (generally due to a poor splice or poor start-up);
h) Entrapped end;
j) Package too soft;
k) Package too hard;
m) Defective or dirty transfer;
n) Dirt sports and mildew;
p) Bad build of the package;
q) Package unflanged with loops on their end faces;
r) Incorrect identification;
s) Package abraded after its manufacture; and
t) Slubs, fuzz balls.

6 SAMPLING

6.1 Lot

The quantity of continuous filament textile glass yarn of one definite designation delivered to a buyer against one despatch note shall constitute a lot.

6.2 Unless otherwise agreed to between the buyer and the seller, the number of packages to be drawn from each lot shall be as given in Table 4.

7 CRITERIA FOR CONFORMITY

The lot shall be declared conforming to the requirements of this standard if the following conditions are satisfied :

a) The average alkali content of the glass used satisfies the requirement given in **5.1.1**;

b) The monofilament diameter meets the requirements given in Table 2;

c) The yarn twist meets the requirements given in **5.2.1** and **5.2.1.2**;

d) The tex count of yarn meets the requirements as given in Table 3 and **5.4.2**;

e) From the test results for breaking strength, the average $\bar{x}$ and the range R shall be calculated and the value of the expression $\bar{x} - 0.6\,R$ is greater than or equal to the corresponding limit specified in Table 3;

f) The average ignition loss of the glass yarn satisfies the requirement given in **5.6**;

g) All the test results of *p*H of aqueous extract of glass yarn and the electrical conductivity of aqueous extract of glass yarn satisfy the relevant requirements; and

h) The lot is reasonably free from the defects given in **5.10**.

8 PACKAGING AND PACKING

8.1 The yarn shall be wound in continuous length on cheeses, cops, bobbins, cones, etc, which shall then be wrapped/enclosed in a suitable moistureproof plastic film or bag. This shall constitute a package. An appropriate number of packages shall be placed in cardboard carton with top and bottom punched boards and guidepins or any other suitable packing material as agreed to between the supplier and the purchaser so as to prevent damage in transit. Adequate care shall be taken to prevent undue movement or packages in the carton.

8.2 The gross mass of the case or carton shall not exceed 100 kg.

9 MARKING

9.1 Each package shall be tied with a suitable label on which the following information shall be marked :

a) Name of the material;
b) Indication of the source of manufacture;
c) Month and year of manufacture;
d) Designation of yarn and monofilament diameter;
e) Identification code of yarn (*see* Table 1); and
f) Any other information as stated in the contract or order.

9.2 BIS Certification Marking

Each package may also be marked with the Standard Mark.

9.2.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986, and the Rules and Regulations made thereunder. The details of the conditions under which a licnece for the use of the Standard Mark may be granted to manufacturers or producers, may be obtained from the Bureau of Indian Standards.

Table 4 Selection of Samples

(*Clause* 6.2)

Sl No.	Total Number of Packages in the Lot	Sample Size (Number of Packages)	Maximum Number of Packages to be Taken per Case							
			Number of Packages per Case							
			1 to 2	3 to 4	5 to 8	9 to 12	13 to 25	26 to 50	51 to 100	101 to 180
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i)	Less than 3	All	—	—	—	—	—	—	—	—
ii)	3 to 8	3	1	2	2	—	—	—	—	—
iii)	9 to 15	3	2	2	2	3	3	—	—	—
iv)	16 to 25	4	2	2	3	3	4	—	—	—
v)	26 to 40	5	2	2	3	4	4	5	—	—
vi)	41 to 65	7	2	2	3	4	5	7	7	—
vii)	66 to 110	10	2	2	3	4	5	7	10	10
viii)	111 to 180	15	2	3	3	4	5	7	10	15
ix)	181 to 300	20	2	3	3	4	5	7	10	15
x)	301 to 500	25	2	3	4	5	5	9	13	15
xi)	501 to 800	30	2	3	4	5	5	9	13	15
xii)	801 to 1 300	35	2	3	4	5	5	9	13	15
xiii)	1 301 to 3 200	40	2	3	4	5	6	10	13	15
xiv)	3 201 to 10 000	50	2	3	4	5	6	10	13	15

For example — If the batch consists of 36 cases and there are 9 packages per case then total number of packages = $9 \times 36 = 324$.

From Table 4, Sl No. (x) and col 3, the number of packages to be selected = 25.

Now reading in col 7 along Sl No. (x) we get the number of cases to be selected equal to 5. So in lot of 36 cases :

a) 5 cases have to be selected, and

b) from each of the case 5 packages have to be selected.

NOTE — For lots above 10 000 packages or for cases containing more than 180 packages, sampling shall be the subject to an agreement between the supplier and the purchaser.

ANNEX A

(*Clause* 5.1.2)

DETERMINATION OF DIAMETER OF MONOFILAMENT

A-1 APPARATUS

A-1.1 Projection Microscope

Having a magnification of 1 000 X and having a movable stage on which a slide can be mounted; and capable of measuring accurate to the nearest 0.1 µm.

A-1.2 Glass Slides

Of size suitable for mounting on the stage of the projection miscroscope.

A-1.3 Thin Glass Cover Slips

For the slides.

A-1.4 Mounting Medium

Comprising equal volumes of glycerine BP and distilled water.

A-1.5 A Pair of Tweezers

A-1.6 A Glass Rod

Of 150 mm length and 3 mm or 6 mm diameter.

A-1.7 A Wire Mesh Basket

Approximately 100 mm × 75 mm × 25 mm size made from stainless steel.

A-1.8 A Muffle Furnace

Capable of operating at 550 ± 25°C.

A-2 PROCEDURE

A-2.1 Weigh a test sample of about 5 g free from foreign matter with the help of razor blades, cut the filaments into fibres of 1 cm to 2 cm size. The test sample may or may not contain a resin binder or size.

NOTE — If the test is being used to check fibre diameter in relation to a particular sliver tex then the sample shall be taken from a nominal tex package, or the actual tex shall be quoted.

A-2.2 If the sample is bonded or sized, place it in the wire mesh basket and heat it in the muffle furnace at 550 ± 25°C until all traces of binder or size are removed.

NOTE — Unbonded or unsized sample does not require this form of treatment.

A-2.3 Preparation of Slides

A-2.3.1 Using the glass rod, place one drop of glycerine solution on a slide.

A-2.3.2 Extract a small number of fibres from the sample using tweezers, immerse them in the glycerine drop on the slide and spread them out to cover an area approximately equal to that of the cover slip.

A-2.3.3 Place the cover slip on the top of the glycerine/ fibre mixture.

A-2.3.4 Prepare sufficient number of slides to enable the total number of readings to be taken. Twenty-five diameter readings shall be taken from each slide.

A-2.4 Measurement of Monofilament Diameter

A-2.4.1 Mount a slide on the microscope stage and roughly focus the image.

A-2.4.2 Move the stage in any one direction until no more fibres cross the field of vision. Then move the stage in the opposite direction until the first fibre appears at the centre of the screen. Then focus the image exactly.

A-2.4.3 Read the diameter of monofilament to the nearest 0.5 micron using a rule graduated in 0.5 mm.

NOTE — 1 mm on the rule = 1 µm filament diameter × 1 000.

A-2.4.4 Move the stage until a second fibre appears at the centre of eyepiece. Re-focus the image and read the monofilament diameter as in **A-2.4.3**.

A-2.5 Calculation of Mean Fibre Diameter and Its Standard Deviation

A-2.5.1 Establish the number of fibres (f_i) having an identical diameter (x_i). Multiply each diameter (x_i) by the number of fibres (f_i) of this diameter.

A-2.5.2 Calculate the mean diameter ($\bar{x}$) as follows:

$$\bar{x} = \frac{\sum f_i x_i}{n}$$

where

$n = \sum f_i$ = total number of fibres tested.

A-2.6 Calculate the standard deviation(s) of the frequency distribution by either of the following formula :

$$s = \sqrt{\frac{f_i\,(x_i - \bar{x})^2}{n - 1}}$$

or

$$\sqrt{\frac{1}{n-1}\left[\sum f_i x_i^{\,2} - \frac{(\Sigma f_i x_i)^2}{n}\right]}$$

ANNEX B

(*Clauses* 5.4.1, 5.4.2 *and* 5.6)

DETERMINATION OF LINEAR DENSITY AND IGNITION LOSS OF GLASS YARN

B-1 TERMINOLOGY

B-1.1 Linear Density

The mass per unit length of desized oven-dried glass yarn expressed in Tex System.

B-1.2 Pre-tension

The tension applied to a yarn or roving before determining the linear density or the twist.

B-1.2.1 Value of yarn pre-tension (F) applied with a tolerance of ± 10 percent, of textile glass continuous filament yarn, is given by the formula:

$$F_{\text{(Newtons)}} = \frac{A_{\text{(tex)}}}{200} = \frac{A_{\text{(decitex)}}}{2\,000}$$

where A is the sum of the nominal linear densities of the strands constituting the yarn.

B-1.2.2 The strand pre-tension of a yarn is expressed in newtons according to Table 5.

Table 5 Strand Pre-tension

(*Clauses* B-1.2.2 *and* B-4.1)

Linear Density		Pre-tension in Newtons
In Tex	In Decitex	
125	1 250	0.40
190	1 900	0.50
340	3 400	0.75
680	6 800	1.00
2 000	2 000	2.00

For intermediate linear densities, calculate the normal pretension by interpolation.

B-2 PRINCIPLE

B-2.1 A specimen of known length of glass yarn after desizing is calcined to constant mass at a standard temperature of 625 ± 20°C and then linear density is calculated in grams per kilometre.

NOTE — For glass yarns which are unstable at the above mentioned temperature, a temperature between 500 and 600°C may be chosen according to glass specification or as per agreement between the buyer and the seller. The chosen temperature must be kept constant within ± 20°C tolerance.

B-3 APPARATUS

B-3.1 Muffle Furnace

Capable of maintaining the standard temperature of 625 ± 20°C, or the chosen temperature ± 20°C.

B-3.2 Desiccator

Containing a suitable desiccant (for example, silica gel, calcium chloride, phosphorous pentaoxide).

B-3.3 Specimen Holder

B-3.4 Stainless Steel Tongs

B-3.5 Balance

Accurate to 0.1 mg.

B-3.6 Wrap Reel

For the unwinding of the yarn, the perimeter preferably being equal to 1 m, equipped with a revolution counter working from a set value to zero or *vice-versa*.

B-3.7 Air-Ventilated Oven

For drying the specimen, capable of being controlled at 105 ± 2°C or 80 ± 2°C or the chosen temperature ± 2°C (*see* Note under **B-5.1.2.2**).

B-4 TEST SPECIMEN

B-4.1 From each package selected in **6.2**, unwind under a standard pre-tension (*see* Table 5), taking care to avoid any modification of twist during the operation, test specimen of length given in Table 6.

B-4.1.1 For plied yarn, take the length of specimen corresponding to that of the single yarn from which it was constructed, divided by the number of ends constituting the plied yarn.

B-5 PROCEDURE

B-5.1 Desize the test specimen (*see* **B-4.1**) as described in **B-5.1.1** and **B-5.1.2**.

B-5.1.1 *Weighing of Holder*

Stabilize the mass of holder by placing it in the muffle furnace controlled at a temperature of 625 ± 20°C or at the chosen temperature between 500 and 600°C (*see* **B-2.1**). Cool the holder in the desiccator in standard atmosphere of 65 ± 2 percent relative humidity and 27 ± 2°C temperature. Weigh the holder to an accuracy of 0.001 g. Note the mass of holder (m_0) in g.

Table 6 Length of Specimen

(*Clause* B-4.1)

Linear Density, T_t (Tex)	Length of Yarn to Take (m)
$T_t < 5$	2 000
$5 \leq T_t < 10$	1 000
$10 \leq T_t < 50$	500
$50 \leq T_t < 200$	100
$200 \leq T_t < 500$	50
$500 \leq T_t < 1\,000$	20
$1\,000 \leq T_t < 2\,500$	10
$2\,500 \leq T_t < 5\,000$	5
$T_t \geq 5\,000$	Length such that the mass lies between 5 g and 25 g

B-5.1.2 *Weighing of Dried Test Specimen Plus Holder*

B-5.1.2.1 Place the test specimen on the holder.

B-5.1.2.2 Place the holder with the specimen in the oven, controlled at 105 ± 2°C. In the case of sized yarn, the standard temperature shall be 80 ± 2°C.

NOTE — In the case of textile glass yarn containing components which are volatile or susceptible to change at these temperature, a lower temperature may be chosen by agreement between the interested parties; it shall be maintained constant to within ± 2°C.

B-5.1.2.3 Heat the specimen for at least one hour.

B-5.1.2.4 Remove the specimen with its holder from the drying oven and allow to cool in standard atmosphere of 27 ± 2°C temperature and 65 ± 2 percent relative humidity for 30 min. Weigh the whole (specimen ± holder) and note the reading to the nearest 0.001 g as m_1.

B-5.1.3 *Calcination of Test Specimen*

Place the test specimen flat on the holder and put the holder with the specimen in the muffle furnace controlled at 625 ± 20°C or at the chosen temperature between 500 and 600°C (*see* **B-2.1**). Allow to burn for 5 min with the door of furnace open to allow volatile products to escape from the furnace thus preventing their redeposition on the specimen or the holder. Then close the door of the furnace and heat for a further 30 min. If a temperature lower than 625°C is chosen, the latter heating period should be increased to at least 1 h. Remove the test specimen and holder from the furnace and transfer to desiccator. Allow to cool in standard atmosphere (*see* **B-5.1.1**). Weigh the calcined test specimen and holder with an accuracy of 0.001 g. Note the mass of calcined test specimen and holder (m_2) in g.

B-6 PRECAUTIONS DURING THE TEST PROCEDURE

B-6.1 Ensure that the test specimen does not come into contact with the furnace during the heating state.

B-6.2 Transfer the test specimen plus holder between furnace, desiccator and balance with great care to avoid loss of material.

B-6.3 Never touch the test specimen with the fingers; but use the tongs.

B-7 EXPRESSION OF RESULTS

B-7.1 Calculate the mass m of each test specimen by the formula :

$$m = m_2 - m_0$$

B-7.2 Calculate the linear density T_t of each test specimen by the formula :

$$T_t = \frac{1\,000\ M}{l}$$

where

m = desized, oven-dried yarn mass, in grams; and

l = length of yarn in the test specimen, in metres.

B-7.3 To calculate the mean actual linear density T_t of the batch or the lot, take the arithmetic mean of the linear densities T_t of the test specimens.

B-7.4 Calculate the coefficient of variation (V) by the following formula correct to one decimal place.

$$V = \sqrt{\Sigma \frac{(T_t - \overline{T}_t)^2 / N}{T_t}} \times 100$$

where

T_t = measured linear density for each test specimen;

$\overline{T}_t$ = mean linear density of batch or consignment; and

N = number of test specimens tested.

B-7.5 Calculate the percentage of linear density deviation (d) by the following formula correct to one decimal place.

$$d = \frac{\overline{T}t - b}{b} \times 100$$

where

$\overline{T}_t$ = mean linear density of the batch or the consignment; and

b = standard value of linear density (*see* Table 3).

B-7.6 Calculate the percentage ignition loss (L) of each test specimen by the formula :

$$L = \frac{m_1 - m_2}{m_1 - m_0} \times 100$$

where

m_0 = mean, in grams, of the holder;

m_1 = mass, in grams, of the holder plus dried specimen; and

m_2 = mass in grams, of the holder plus dried and calcined specimen.

B-7.7 Report

The report shall include the following particulars :

a) Actual linear densities (T_t) of all the individual test specimens;

b) The mean actual linear density ($\bar{T}_t$) of the batch or the consignment;

c) The coefficient of variation (V) of individual values for all the measurements;

d) The percentage of linear density deviation (d) of individual values for all the measurements;

e) The average ignition loss in percentage; and

f) The heating time in the oven and the temperature of the muffle furnace, if the latter differs from 625 ± 20°C.

ANNEX C

(*Clause* 5.5)

DETERMINATION OF TENSILE STRENGTH

C-1 APPARATUS

C-1.1 The tensile testing machine used shall include :

a) a pair of suitable clamps to grip the specimen;

b) means for elongating the specimen; and

c) a meehanism which will indicate or record the load applied to the specimen and the corresponding elongation.

C-1.1.1 Following types of testing machines may be used:

a) constant rate of load;

b) constant rate of specimen extension; or

c) constant rate of traverse of driven clamp.

C-1.1.2 The testing machine shall be capable of testing specimens having a nominal gauge length of 250 ± 1 mm.

NOTE — By agreement between the interested parties, other nominal gauge length may also be used, although in these conditions the test results may be slightly different than those obtained with the gauge length of 250 ± 1 mm.

C-2 CONDITIONING AND TESTING

C-2.1 Pre-condition the packages selected by exposing in an atmosphere having temperature of 80 ± 2°C and relative humidity not exceeding 10 percent until a substantially constant mass is obtained.

C-2.2 After pre-conditioning, bring the packages selected to a state of moisture equilibrium by exposing them in a standard atmosphere of 65 ± 2 percent relative humidity and 27 ± 2°C temperature for at least 3 h.

C-2.3 The test specimens shall be tested in a standard atmosphere given in **C-2.2.**

C-3 TEST SPECIMENS

C-3.1 Take ten specimens from each package selected having a length of at least 600 mm of yarn; a length of 1 000 mm facilitates handling and preservation of twist.

C-3.1.1 The yarns to be tested shall be taken from the package in such a way so as to avoid any abnormal change in twist. Preferably the yarn shall be unwound tangential, by causing the package to rotate around its own axis, in such a way that the yarn remains constantly under tension. Remove the outer layer of yarn and then take five test specimens leaving 5 m after drawing each sample, each test specimen consisting of an entirely new portion of yarn; then unwind approximately 100 m of the yarn before taking the last five test specimens in a manner described above, these being made up from an entirely new portion of yarn.

C-4 PROCEDURE

C-4.1 Check that the distance between the grips of the testing machine is 250 ± 1 mm (*see also* Note

below **C-1.1.2**). Check that the grips are correctly aligned and parallel in such a way that the force applied to the test specimen does not produce any angular displacement of the grips.

C-4.2 After conditioning as specified in **C-2.2**, grip the test specimen in tensile tester so that the axis of the test specimen is perpendicular to the edge of the clamps.

C-4.3 Apply to the test specimen a pre-tension of 5 ± 0.5 mN/tex, calculated from the nominal linear density of the yarn, unless the pre-tension extends the specimen by more than 0.5 percent in which case a lower pre-tensison (for example, 2.5 mN/tex or 1 mN/tex), may be used as per the agreement between all the interested parties.

C-4.4 Set the moving clamps in motion at a test speed of 300 mm/min. After breaking of the specimen, record the maximum force and elongation at break. Return the moving clamp to its zero position and remove the ends of the broken specimen.

C-4.5 Disregard any observation made on test specimens that slips between the jaws, or that break in, or within 10 mm of the jaws. The number of observations that are ignored shall be counted, if it exceeds 10 percent of the number of specimens tested, the clamps shall be readjusted.

C-4.6 Calculate the arithmetic mean of the individual results obtained for the breaking force and percentage elongation at break.

ANNEX D

(*Foreword*)

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